R E P O R T   R E S U M E S

ED 015 082 RE 000 217

A DEVELOPMENTAL STUDY OF FEATURE-PROCESSING STRATEGIES IN LETTER DISCRIMINATION.

BY- YONAS, ALBERT GIBSON, ELEANOR J.

EDRS PRICE MF-$0.25 HC-$0.48 10P.

DESCRIPTORS- PATTERNED RESPONSES, *PERCEPTUAL MOTOR LEARNING, *REACTIVE BEHAVIOR, RESPONSE MODE, RETENTION, DISCRIMINATION LEARNING, VISUAL DISCRIMINATION,

A STUDY WAS CONDUCTED TO DETERMINE WHETHER PEOPLE CAN CHANGE THEIR PERCEPTUAL PROCESSING STRATEGIES TO INCLUDE TESTS FOR THE PRESENCE OF ONLY THOSE STIMULUS FEATURES NECESSARY FOR THE TASK AT HAND. LEARNING DURING PRACTICE AND THE EFFECT OF AGE ON THE ABILITY TO USE OPTIMAL STRATEGIES WERE INVESTIGATED. A DISJUNCTIVE REACTION TIME PROCEDURE WAS EMPLOYED. ROMAN CAPITAL LETTERS WERE DIVIDED INTO POSITIVE AND NEGATIVE SETS, AND THERE WERE 135 TRIALS FOR EACH OF THREE CONDITIONS. THE PERFORMANCE OF SECOND AND SIXTH GRADERS WAS COMPARED WITH THE PERFORMANCE OF COLLEGE SOPHOMORES. REACTION TIME AND ERRORS WERE RECORDED. A MIXED ANALYSIS OF COVARIANCE WAS RUN FOR GRADE, CONDITION, AND PRACTICE AS FACTORS. RESULTS INDICATE THAT PERCEPTUAL LEARNING DID OCCUR AND THAT MOTOR SKILLS DID IMPROVE, ALTHOUGH DIFFERENTIAL RATE OF IMPROVEMENT WAS NOT ACCOUNTED FOR. FIGURES ARE INCLUDED. (MC)

A Developmental Study of Feature-Processing Strategies in Letter Discrimination

Albert Yonas and Eleanor J. Gibson

Cornell University

The question we were concerned with was whether people can change their perceptual processing strategies to include tests for the presence of only those stimulus features necessary for the task at hand. Eleanor Gibson has proposed a theory of perceptual learning which hypothesizes that differentiation requires the search for, and processing of, distinctive features of stimulus displays. These are analogous to Jakobson and Halle's distinctive features of phonemes. Furthermore, perceptual processing, given practice in a discrimination task, would be expected to progress toward strategies which use the most economical feature list. We have tried to demonstrate that such perceptual learning does occur when the task presented to the subject makes such a change adaptive.

The method was to set up an experimental situation where it would be possible, given practice, for the subject to differentiate the displays presented on the basis of a single distinctive feature, as contrasted with a control condition where an equally economical search would not be possible. If performance in the experimental and control conditions is initially the same but learning curves show asymptotic performance to be lower in the experimental condition, we infer that the perceptual process has taken advantage of the potential strategy and narrowed the search to the single feature, thus reducing the information processed before the decision is made. We asked whether such learning occurs in the course of practice and whether the ability to use such optimal strategies improves with age. We therefore compared the performances of second, and sixth grade children with that of college sophomores over 135 trials of practice.

METHOD

We chose a disjunctive reaction time procedure (similar to one used by Sterinburg) in which the subject is told to look for one or more letters (which we will call the positive set). When the single letter presented on a screen before the subject is a member of the positive set, he is required to respond "yes" by moving a lever, as quickly as possible, to one side. If it is not a member of the positive set, he responds "no" by pushing the lever in the opposite direction. The stimuli consisted of nine simplified Roman capital letters--A, O, F, N, V, E, C, H, B. When the subject pressed a button, a tachistoscopic shutter on the slide projector was activated to produce the display, which remained on the screen for 20 milliseconds. At the same time, a Hunter millisecond clock was started and it stopped when the subject pushed the lever.

There were three conditions in the experiment. In the first condition, the positive set contained only one letter (E); the negative set contained the other eight (A, O, F, N, V, C, H, B). In the second condition, the positive set contained three letters, A, O, and F, while the negative set contained the other six (N, V, E, C, H, B). In the third condition, the positive set also contained three letters (A, N, V), the negative set the other six (O, F, E, C, H, B). The division of the letters into the two sets in this last condition is such that processing a single feature, in this case, diagonality, would be sufficient for a decision. That is, a single feature's presence or absence differentiates the negative from the positive set. This is not the case in the AOF condition.

Every subject took part in all three conditions of the experiment. At the beginning of a condition, he was told the positive set and, as an aid to memory, the lever background was labelled with the target letters. Order of conditions and the direction of a positive lever response were counterbalanced over subjects.

The subject was given 135 trials for each condition, each letter appearing approximately 15 times in a random order. Response bias thus favored the negative response, but this was equal for the three conditions. Reaction time and errors were recorded.

For each condition, a subject's reaction times were divided into five blocks of 27 trials, and a mean obtained for each block so that initial performance could be compared with subsequent performance. We expected that response time at the beginning of practice would be roughly equivalent for the two conditions containing three members in the positive set, but that with practice they should diverge. The ANV condition, with a single differentiating feature should decrease in latency so as to approach the single target condition. The AOF condition, without any single differentiating feature, should benefit less from practive.

Fig. 1 shows curves for the three conditions, the five blocks of trials on the abscissa and the mean latency on the ordinate. All three age groups have been combined. As you can see, the two conditions with three letters in the positive set are equal in latency in the first trial block. Both curves descend with practice, but the ANV conditions shows a greater decrease in latency, approaching the curve for the single target condition, which is lower throughout.

We expected that the single target condition would be lower, since differentiation of one letter from a set, rather than three, should reduce the number of features that must be processed.

Fig. 2 shows reaction times for the three conditions plotted by blocks of 27 trials, with the three age groups graphed separately. The relationship between condition and practice is similar for each age group, but latency decreases enormously with age.

A mixed analysis of variance was run with subjects-within-grade, grade, condition, and practice as factors. The means of the 27 trials for each subject within each block were used as the data for the analysis. The main effect of conditions was significant at less than the .001 level; the interaction between practice and conditions was also significant at the same level. The difference between the two three-target conditions on the fifth block of trials was significant at less than the .01 level by a Tukey test.

Grade and condition did not yield a very significant interpretable interaction. Fig. 3 shows age curves for the three conditions on the last block of 27 trials. The youngest children, despite the fact that their responses are much slower, show the same greater decrease in latency for the ANV condition as do adults. If the younger children are actually not as adept at switching to an economical processing strategy as adults, perhaps this is made up for by the advantage of their not having to overcome long-practiced habits of exhaustive processing of a complete feature list.

The predicted difference between the two three-target conditions, although statistically significant, is not very large (29 milliseconds). This seemed reasonable to us since the amount of practice given was not enough to bring the subject anywhere near asymptote, and it was further counteracted by years of overlearned processing habits for letter discriminiation. We decided, therefore, to run a few subjects on all three conditions until they reached asymptote. Three subjects were started and given 405 trials per day, approximately 40 minutes. One proved to be irregular in attendance and the second showed erratic curves relating principally to vacation times and illness. However, the third stayed with the practice for 34 days.

Figure 4.

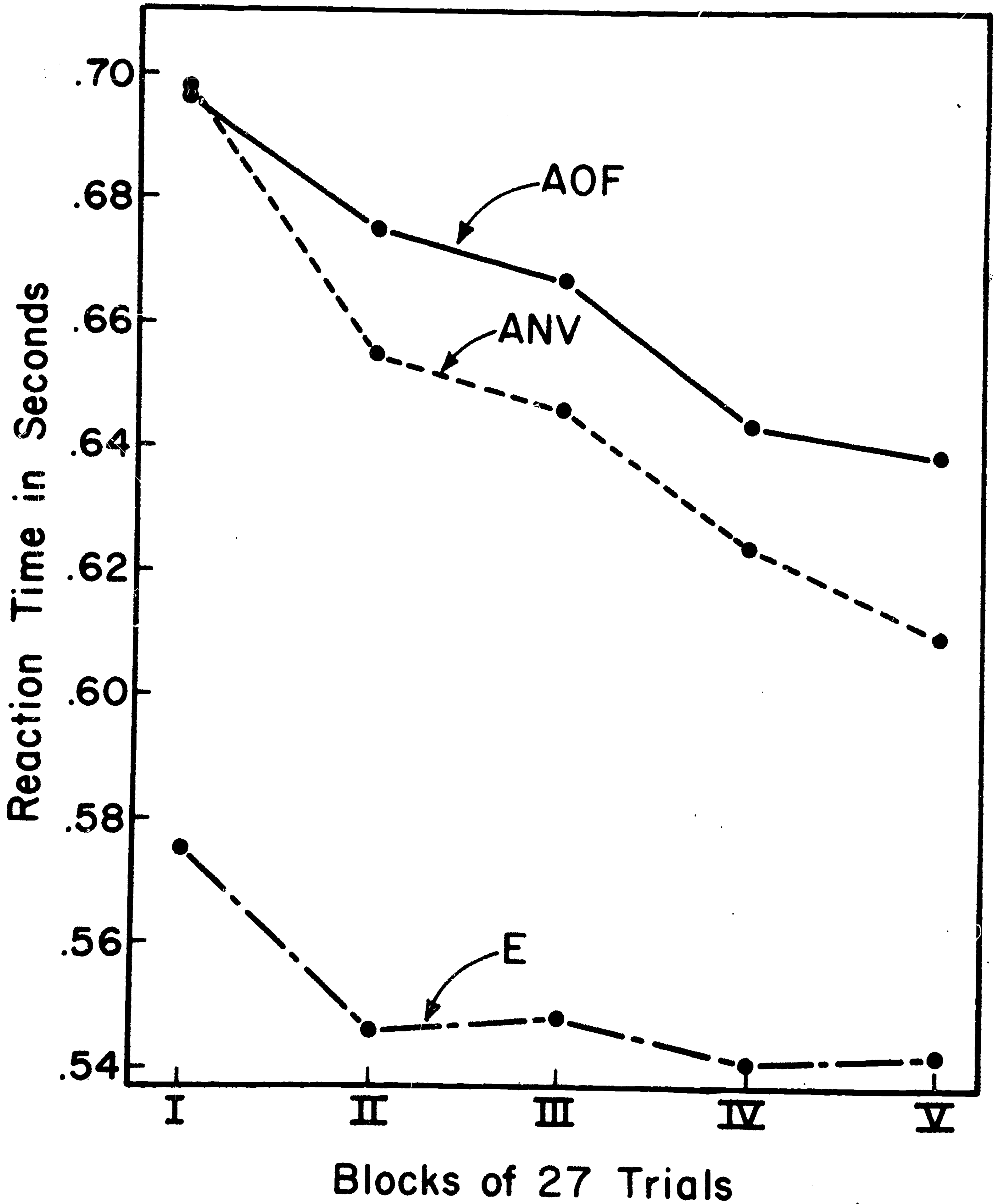
The curves show an asymptotic trend and, most interestingly, the condition with a single differentiating feature, ANV, appears to have dropped to the level of the single target condition. Unfortunately, this is only the data of a single subject and the day-to-day variability is great. It seems clear that this sort of perceptual learning is a slow process. With letters, it has been going on for a long time and a shift to a new task, where some distinctive features can be disregarded, cannot be expected to bring instant changes, however adaptive for that task.

It would be wise, of course, to avoid the difficulty of requiring that learning in an experiment go against long-standing habits. This is not easy; such features as curves and diagonal lines that are critical for alpha-numeric characters will form part of the subject's potential vocabulary even for artificial characters. Nevertheless, we are preparing to repeat this experiment using made-up forms rather than letters, and this may give us a more easily manipulated learning situation.

In conclusion, I feel we have demonstrated that perceptual learning does occur. And, although motor skill does improve in the present experiment, it cannot account for the differential rate of improvement in our main experimental conditions.

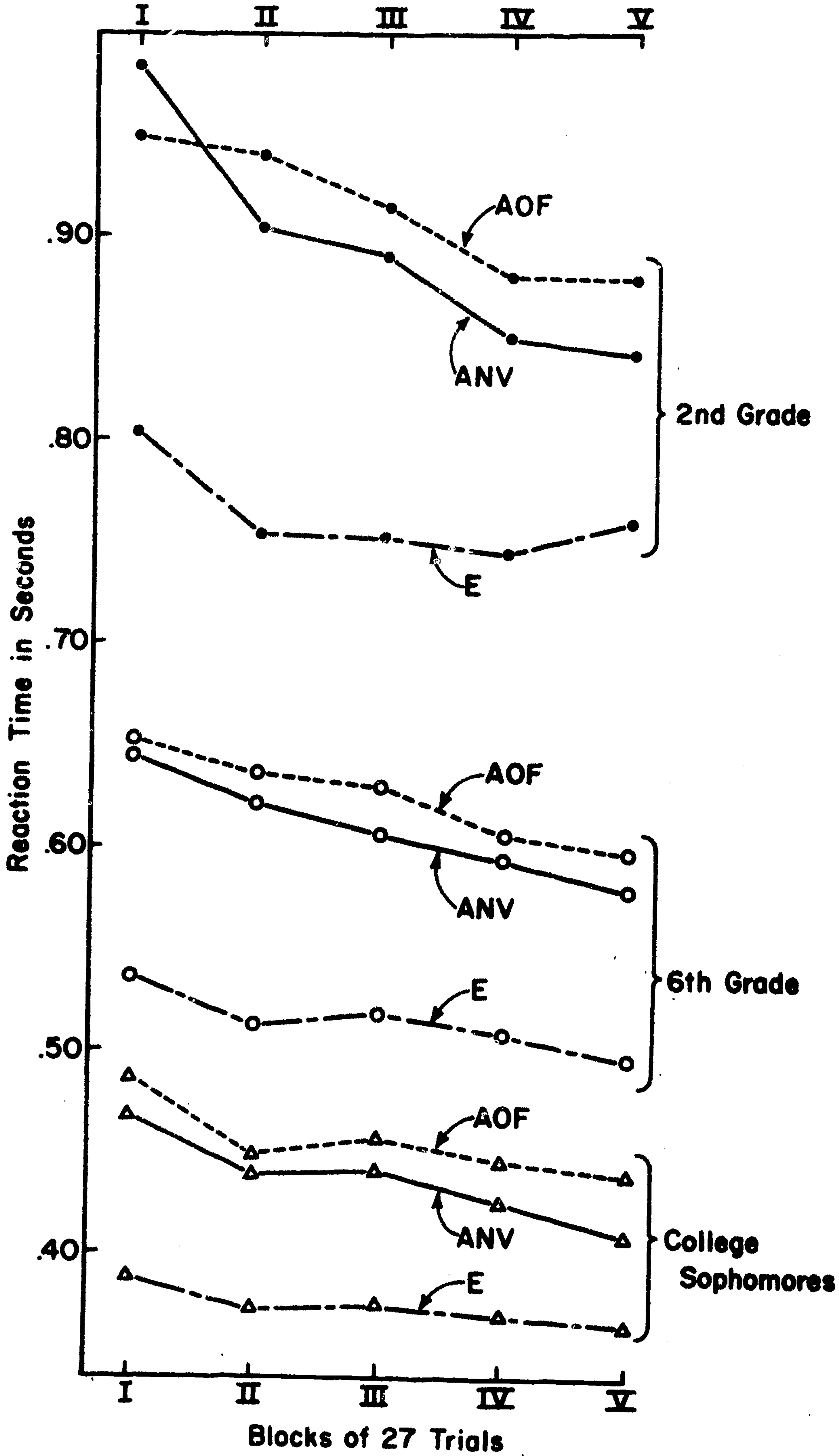
On the other hand, if we can rule out improvement in motor skill, is it possible to locate the learning in some more intellectualized process than perception, some sort of cognitive insight or deliberate instruction of the "intelligence?" I do not think so, because we found that most subjects could not tell us any single differentiating feature in the relevant condition. Also, the improvement was a gradual thing, far from looking like "insight."

We believe, therefore, that perceptual learning <u>occurs</u>--and it is an adaptive, self-regulating change in the direction of reducing the information to be processed. At this point, the question of where and how these changes in processing strategy occur is unanswered.

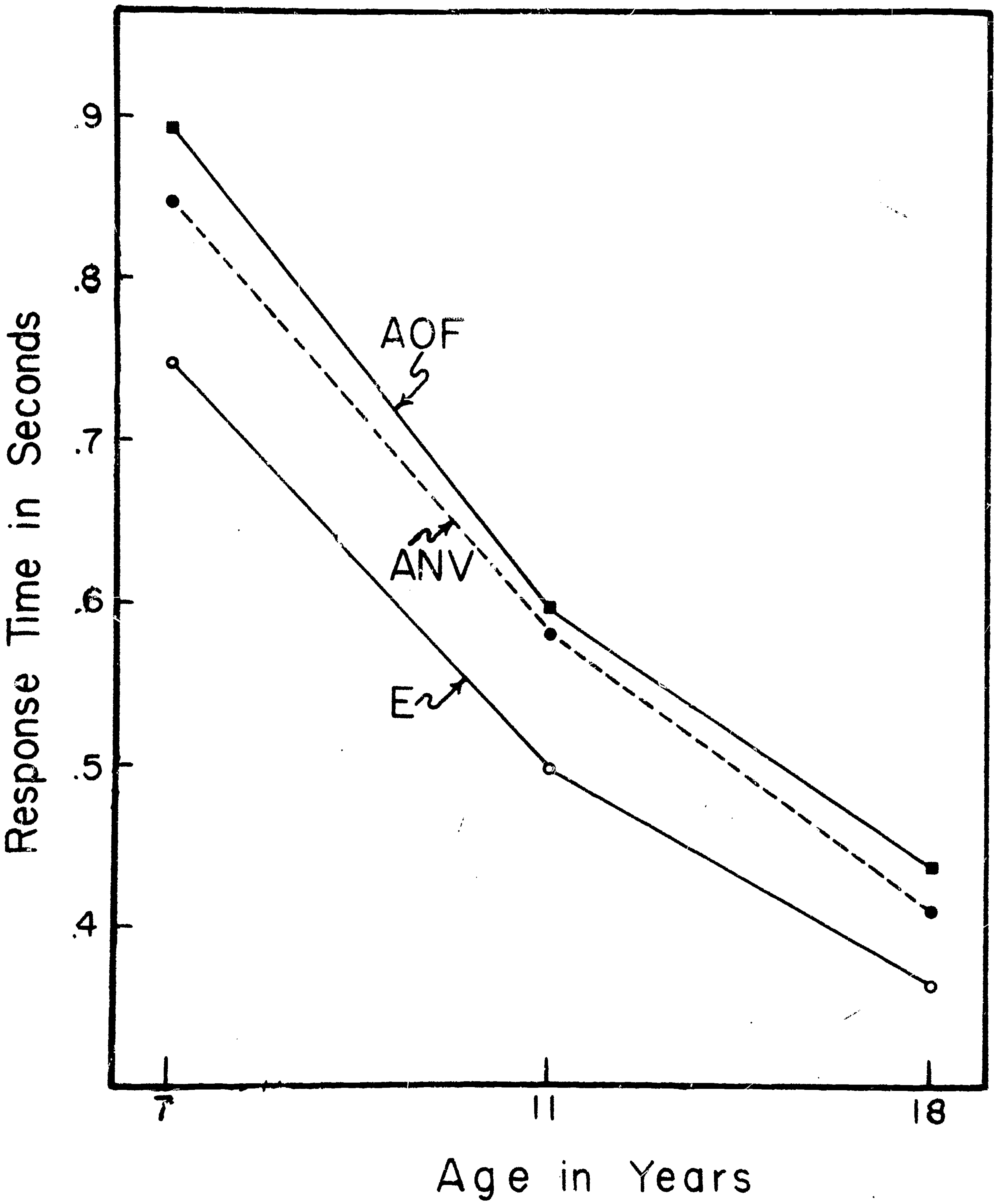


Reaction Time in Seconds
.70
.68
.66
.64
.62
.60
.58
.56
.54
AOF
ANV
E
I
II
III
IV
V
Blocks of 27 Trials

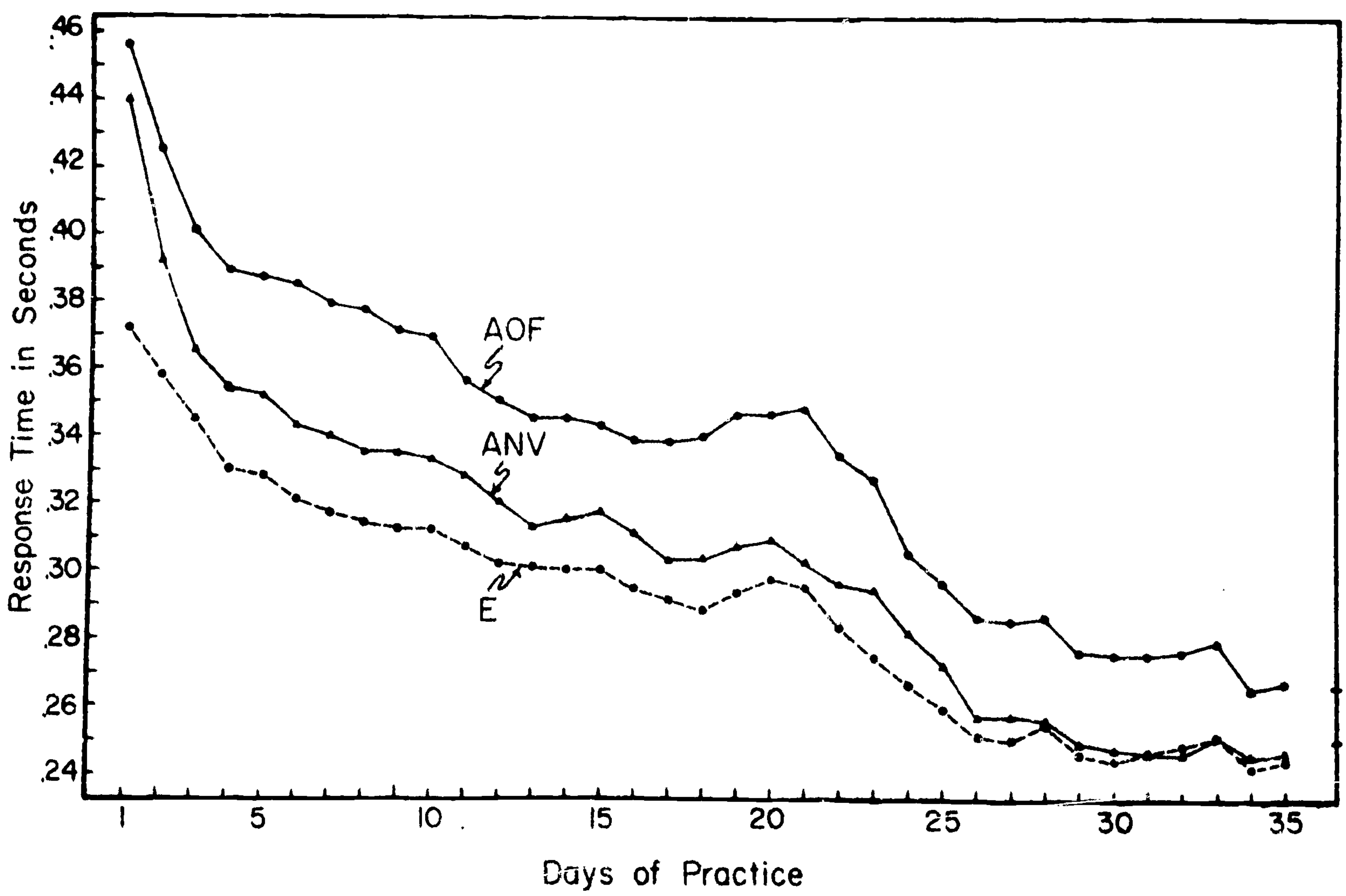
ERIC



I
II
III
IV
V
.90
.80
.70
.60
.50
.40
Reaction Time in Seconds
AOF
ANV
E
2nd Grade
AOF
ANV
E
6th Grade
AOF
ANV
E
College
Sophomores
I
II
III
IV
V
Blocks of 27 Trials



Response Time in Seconds
.9
.8
.7
.6
.5
.4
AOF
ANV
E
7
11
18
Age in Years



.46
.44
.42
.40
.38
.36
.34
.32
.30
.28
.26
.24
Response Time in Seconds
AOF
ANV
E
1
5
10
15
20
25
30
35
Days of Practice